

MODULAR VENTILATING EXHAUST FAN ASSEMBLY AND METHOD

BACKGROUND OF THE INVENTION

Ventilating exhaust fans, such as those typically included in bathrooms, draw air from within an area and pass the exhausted air out to another location, such as through a vent in the gable or roof of a home or other building structure. Ventilation is thus provided for the area. Centrifugal exhaust fans typically include a rotating fan wheel having a plurality of vanes that create an outward airflow which, in turn, is directed out of an outlet opening. The fan wheel is typically coupled to a driving motor supported within the fan housing. In some cases, a curved fan scroll is employed to channel air around the fan, and can be defined by a housing wall of the fan or by a separate element or structure within the fan housing.

Many typical exhaust fans currently in use include a housing positioned within a building structure, such as in an aperture in a wall or ceiling. The housing can be secured in the aperture in a number of conventional manners, such as by being attached to wall or ceiling joists, or by being attached to other structure in the wall or ceiling.

In some cases, it may be desirable to replace an exhaust fan for one or more reasons. For example, an old exhaust fan may need to be replaced when broken, or may generate unacceptable vibration or noise during operation. As another example, it may be desirable to replace an old exhaust fan with one that is more powerful and/or more efficient, or that has one or more features or characteristics different than the existing exhaust fan. However, conventional exhaust fans can be relatively difficult and time consuming to remove and replace, typically requiring the assistance of a qualified electrician, the disconnection and re-connection of associated ductwork, and the removal and re-installation of the entire exhaust fan from the building structure.

In light of the shortcomings and limitations of conventional ventilating exhaust fans, new ventilating exhaust fans would be welcome in the art.

SUMMARY OF THE INVENTION

Some embodiments of the present invention provide a ventilation exhaust fan comprising a housing having a fluid inlet through which fluid is received within the housing and a fluid outlet through which fluid exits the housing, wherein the housing

is adapted to interchangeably receive a first module having a first support plate and a second module having a second support plate, each of the first and second modules having at least one of a motor and a fan wheel operable to generate a flow of fluid out of the fluid outlet, and wherein at least one of the motor and the fan wheel of the first module has a size different than the at least one of the motor and the fan wheel of the second module, respectively. In some embodiments, the size is an axial length of each fan, or alternatively, a dimension of each motor. In other embodiments, the size is a measure of the output of each motor.

In some embodiments of the present invention, a replacement ventilation exhaust module for replacement of an existing ventilation module in a fan housing is provided, wherein the existing ventilation module has a first support plate, a first motor coupled to the first support plate, and a first fan wheel drivably coupled to the first motor, wherein the first support plate is releasably coupled within the fan housing at a location, wherein the ventilation exhaust module comprises a replacement support plate adapted to be releasably coupled to the fan housing at the location, a replacement motor is coupled to the replacement support plate, and a replacement fan wheel is drivably coupled to the replacement motor, and wherein at least one of the replacement motor and replacement fan wheel is different in size than the first motor and first fan wheel, respectively. In some embodiments, the size is an axial length of each fan, or alternatively, a dimension of each motor. In other embodiments, the size is a measure of the output of each motor.

In another aspect of the present invention, a ventilation exhaust fan is provided, and comprises a fan housing having a plurality of walls defining an interior space and an outlet through which fluid is exhausted from the fan housing, a first mounting plate, a first motor coupled to the first mounting plate, a first fan drivably coupled to the first motor, wherein the first mounting plate, the first motor, and the first fan are removable from and insertable within the fan housing as a single unit, a second mounting plate, a second motor coupled to the second mounting plate, and a second fan drivably coupled to the second motor, wherein the second mounting plate, the second motor and the second fan are removable from and insertable within the fan housing as a single unit, and at least one of the first motor and first fan has a size different than the second motor and second fan, respectively. In some embodiments, the size is an axial length of each fan, or alternatively, a dimension of each motor. In other embodiments, the size is a measure of the output of each motor.

In yet another aspect of the present invention, a method of changing a ventilation exhaust fan is provided, and comprises providing a housing defining an interior space and having an opening communicating between the interior space and an exterior of the housing, providing a first module coupled to the housing, wherein the first module has a first support plate, a first fan wheel, and a first motor operably coupled to the first fan wheel, and wherein at least a portion of the first module extends into the interior space, uncoupling the first module from the housing, withdrawing the first module from the interior space, removing the first support plate from the opening, inserting at least a portion of a second module into the interior space, wherein the second module has a second support plate, and coupling the second module to the housing, wherein the second module has at least one of a second fan wheel and a second motor coupled to the second support plate, and wherein at least one of the second fan wheel and the second motor is different in size than the first fan wheel and the first motor, respectively.

Further aspects of the present invention, together with the organization and operation thereof, will become apparent from the following detailed description of the invention when taken in conjunction with the accompanying drawings, wherein like elements have like numerals throughout the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is further described with reference to the accompanying drawings, which illustrate certain embodiments of the present invention. However, it should be noted that the invention as disclosed in the accompanying drawings is illustrated by way of example only. The various elements and combinations of elements described below and illustrated in the drawings can be arranged and organized differently to result in embodiments which are still within the spirit and scope of the present invention.

In the drawings, wherein like reference numeral indicate like parts:

Fig. 1 is an exploded perspective view of a ventilating exhaust fan according to an exemplary embodiment of the present invention;

Fig. 2a is a sectional view of the ventilating exhaust fan shown in Fig. 1 and illustrating the mounting of a first module within the fan housing;

Fig. 2b is a sectional view of the ventilating exhaust fan shown in Fig. 1 and illustrating the mounting of a second module within the fan housing different than the first module;

Fig. 3 is a perspective view of a ventilating exhaust fan according to another exemplary embodiment of the present invention;

Fig. 4 is an exploded perspective view of the ventilating exhaust fan illustrated in Fig. 3;

Fig. 5 is a partial section view of the ventilating exhaust fan shown in Figs 3 and 4, taken along line 5-5 of Fig. 3 and illustrating the interaction between the motor support plate and the fan scroll of the exhaust fan;

Fig. 6 is partial section view of the ventilating exhaust fan shown in Figs. 3 and 4, taken along line 6-6 of Fig. 5 and further illustrating the interaction between a detent formed on the motor support plate and the fan scroll;

Fig. 7 is a section view of the ventilating exhaust fan shown in Figs. 3 and 4, taken along line 7-7 of Fig. 3 and illustrating view holes formed in a back wall of the fan housing used to aid in alignment of the fan housing along a structural member;

Fig. 8 is a section view of the ventilating exhaust fan shown in Figs. 3 and 4, taken along line 8-8 of Fig. 3 and illustrating a bend down tab used to aid in alignment of the fan housing along a structural member;

Fig. 9 is a partial top plan view of the ventilating exhaust fan shown in Figs. 3 and 4, illustrating a receptacle panel installed within the fan housing;

Fig. 10 is a section view of the ventilating exhaust fan shown in Figs. 3 and 4, taken along line 10-10 of Fig. 9 and illustrating the mounting of the receptacle panel within the fan housing;

Fig. 11 is a section view of the ventilating exhaust fan shown in Figs. 3 and 4, taken along line 11-11 of Fig. 9 and further illustrating the mounting of the receptacle panel within the fan housing;

Fig. 12 is a section view of the ventilating exhaust fan shown in Figs. 3 and 4, taken along line 12-12 of Fig. 3 and illustrating the construction of an exhaust flap positioned adjacent to an exhaust outlet of the fan housing;

Fig. 13 is a section view of the ventilating exhaust fan shown in Figs. 3 and 4, taken along line 13-13 of Fig. 4 and illustrating the mounting of the fan wheel onto a drive shaft of the driving motor;

Fig. 14 is an exploded perspective view of the ventilating exhaust fan shown in Figs. 3 and 4, illustrating a two-piece construction of the fan housing;

Fig. 14a is a front view of a first sheet of material used to form a first structural member defining the fan housing shown in Figs. 3 and 4; and

Fig. 14b is a front view of a second sheet of material used to form second structural member defining the fan housing shown in Figs. 3 and 4.

DETAILED DESCRIPTION OF THE INVENTION

Fig. 1, illustrates a ventilating exhaust fan 10 according to an exemplary embodiment of the present invention. The ventilating exhaust fan 10 can be employed to ventilate any room or area, such as a bathroom or other structure. In use, the fan 10 can be mounted in any orientation, such as in a vertical orientation installed in a wall, a horizontal orientation installed in a ceiling, or in any other orientation desired.

In some embodiments, the fan 10 is secured within a wall, ceiling, or other building structure in a partially or fully recessed position. In such cases, the fan 10 can be received within an aperture in the wall, ceiling, or other building structure, and can be secured to any suitable element(s) (e.g., one or more wall or ceiling joists) in order to secure the fan 10 in place within the aperture. A cover or louver 63a of the fan 10 can extend beyond the exterior plane of the ceiling or wall. The fan 10 can operate to draw air through one or more apertures or vents in the louver 63a and to discharge the air through an outlet. In some embodiments, the fan 10 has an outlet fitting 12 through which airflow exits the fan 10. The outlet and/or outlet fitting 12 of the fan 10 can have any shape (round, oval, rectangular, irregular, and the like) for connection to a similarly sized duct that directs the airflow to another location.

Although the embodiments of the present invention refer to the movement, intake, and exhaust of air and airflow, it will be appreciated that the fan 10 of the present invention can be employed to move, intake, and discharge any gas or combination of gasses desired. Accordingly, terms referring to “air” herein and in the appended claims are understood to encompass such other fluids.

The fan 10 can have a housing 14 formed from sheet metal or other suitable material of a thickness sufficient to provide the necessary structural strength for the exhaust fan 10 and components thereof (e.g., the motor 56a and the fan wheel 54a).

The housing 14 can have any shape desired, such as a round shape, a rectangular, triangular, or other polygonal shape, an irregular shape, and the like. By way of example only, the housing 14 illustrated in Figs. 1, 2a, and 2b has a generally rectangular shape, and has a back wall 16, a front wall 18, sidewalls 20, 22, and a base wall 24. Together, the back wall 16, front wall 18, sidewalls 20, 22, and base wall 24 at least partially define an interior space 15 of the fan 10. The back wall 16, front wall 18, and sidewalls 20, 22 can define an opening 27 of the housing 14 between the interior space 15 and an exterior of the housing 14.

In some embodiments of the present invention, fasteners (not shown) are employed to secure the housing 14 (and therefore, the exhaust fan 10) to a building structure. In such cases, the fasteners can attach any part of the housing 14 to the building structure, such as the back wall 16, front wall 18, either sidewall 20, 22, the base wall 24, or flanges located anywhere on the housing 14, and can extend through attachment holes 36, 40 for this purpose. In the illustrated embodiment of Figs. 1-2b, fasteners can pass through attachment holes 36, 40 in mounting flanges 34, 38 adjacent the back wall 16 of the housing 14, thereby securing the back wall 16 of the housing 14 to a joist, sub-joist, wall stud, or any other structural support. In other embodiments, fasteners can pass through one or more of the back wall 16, the front wall 18, either side wall 20, 22 and/or the base wall 24 to secure the housing 14 to the building structure. Any conventional fastener can be employed to secure the housing 14 as just described, such as screws, nails, rivets, pins, posts, clips, clamps, inter-engaging elements, and any combination of such fasteners.

The exhaust fan 10 in the embodiment of Figs. 1-2b is oriented substantially horizontally (i.e., with the base wall 24 being substantially perpendicular to a structural support). However, in alternate embodiments the exhaust fan 10 can also or instead be oriented vertically with respect to any building structure (i.e., with the base wall 24 being substantially parallel to a structural support). In still other embodiments, the exhaust fan 10 can have other orientations with respect to the building structure and its structural support(s), determined at least in part by space constraints, the orientation of structural supports, the spacing between structural supports, and whether the exhaust fan 10 is mounted in a wall or a ceiling.

Field wiring can extend through the building structure and can transmit electrical power to the location of the fan 10. As used herein and in the appended claims, the term “field wiring” includes electrical connections, electrical wiring,

electrical circuits, and any other electrical elements and systems used to transmit or otherwise carry electrical power in the building structure.

In some embodiments, the fan 10 includes an electrical connector 80 for releasable connection to a motor 56a. In other embodiments, the fan 10 can be provided with two or more electrical connectors 80 for supplying electrical power to two or more electrical components, such as a lighting assembly or a nightlight. The electrical connector(s) 80 can be located in a panel 78 as shown in Fig. 1 or in any other wall, framework, or structure of the fan 10. One or more wires 82 can be electrically connected to and extend from the electrical connector 80, and can be connected to field wiring supplying power to the fan 10. Such connections can be located within an enclosure defined at least in part by the panel 78, if employed. By way of example only, in the illustrated embodiment of Figs. 1-2b, an electrical connector 80 is retained in a panel 78 removably secured to walls 20, 18 of the housing 14. An electrical enclosure is defined between the panel 78, a portion of each of the walls 20, 18, and a portion of the base wall 24. The panel 78 can have flanges that are slidably received within slots in the side and front walls 20, 18 to retain the panel 78 in place as best shown in Fig. 1.

The housing 14 can be provided with one or more suitable openings through which field wiring can extend. Such openings can be defined in one or more wiring plates, or can be defined in one or more walls of the housing as shown in Fig. 1. If desired, a plate 84 can be used to cover one or more holes not used to route wires in the electrical connection of the fan 10. As explained below in greater detail, the electrical connector 80 can be employed to supply electrical power to one or more electrical components of the exhaust fan 10, including, for example, a fan motor, a lighting assembly, and the like. Additionally, in some embodiments, the electrical connector 80 is selectively engageable with a number of different electrical connectors, thereby facilitating electrical connection between the field wiring 43 and a number of different electrical components selectively installed in the housing 14.

With continued reference to the illustrated exemplary embodiment of Figs. 1-2b, a sidewall 22 of the housing 14 defines an outlet opening 30 to which an outlet fitting 12 is attached in any conventional manner (although the outlet opening 30 can be in any location on the housing 14 depending at least partially upon the location and orientation of the fan wheel 54a and the motor 56a. If employed, the outlet fitting 12 can be connected to an exhaust duct or other components of an exhaust duct system

extending away from the fan 10 to exhaust air to another location. During operation, the exhaust fan 10 operates to draw air from a room or other area through the opening 27 and to discharge the airflow out through the outlet fitting 12 and the exhaust duct system. In some embodiments, the exhaust duct system includes a flexible fluid conduit. In other embodiments, the exhaust duct system can include other conduits, such as pipes, tubing, hoses, cavities in solid bodies, combinations of such elements and structures, and the like. Therefore, as used herein and in the appended claims, the term “exhaust duct” or “exhaust duct system” refers to any conduit, passage, or chamber (or combinations thereof) through which fluid can be transported, and unless otherwise stated is independent of the length, diameter and other shape, material, flexibility or inflexibility, or other properties of such elements and structures.

As shown in Fig. 1, in some embodiments, the housing 14 supports a centrifugal fan scroll 44. The fan scroll 44 can be coupled to any wall or combination of walls of the housing 14, such as to the sidewall 22, back wall 16, and front wall 18 as shown in Fig. 1. In the illustrated exemplary embodiment, the fan scroll 44 is spot welded to the sidewall 22, back wall 16, and the front wall 18. In other embodiments (not shown), the fan scroll 44 can be connected to the housing via screws, bolts, nails, rivets, pins, posts, clips, clamps, and/or other conventional fasteners, inter-engaging elements on the fan scroll 44 and the housing 14 (e.g., tabs, flanges, or other extensions on the fan scroll 44 inserted within slots, grooves, or other apertures in the housing wall(s), and vice versa), by adhesive or cohesive bonding material, or in any other suitable manner. The fan scroll 44 can define a fan wheel chamber 52 in the housing 14. In still other embodiments (not shown), the exhaust fan 10 can be constructed without a fan scroll 44.

As shown in Figs. 1 and 2a-2b, in some embodiments the fan housing 14 is adapted to selectively and interchangeably receive first and second modules 47a, 47b defining part or all of the moving components of the exhaust fan 10. In other words, and as explained in greater detail below, the exhaust fan 10 can be configured in either of two configurations using the first and second modules 47a, 47b. As discussed in greater detail below, the modules 47a, 47b are different from each other in at least one manner, such as size, shape, efficiency, power, and the like. Features and elements of the first module 47a are identified herein with a reference number and the letter “a”, while corresponding features and elements in the second module 47b include the same reference number and the letter “b”. By using selectively

interchangeable modules 47a, 47b as just described, the exhaust fan 10 can be assembled and installed in a structure with the first module 47a, and can then be reconfigured as needed or desired by removing the first module 47a and replacing the first module 47a with the second module 47b. Similarly, the exhaust fan 10 can be assembled and installed in a structure with the second module 47b and can then be reconfigured as needed or desired by removing the second module 47b and replacing the second module 47b with the first module 47a.

It will be appreciated that while reference is made herein and in the appended claims to an exhaust fan 10 having two modules 47a, 47b and to an exhaust fan 10 having two configurations corresponding to the two modules 47a, 47b, alternate embodiments of the present invention (not shown) can include three, four, or more modules and can be assembled in any number of different configurations corresponding to the modules.

As shown in Figs. 1 and 2a, the first module 47a includes a support plate 58a. The support plate 58a can be a substantially planar member defining an intake aperture 49a. When the support plate 58a is coupled to the housing 14 as will be described in greater detail below, the intake aperture 58a communicates between opposite sides of the support plate 58a to provide fluid flow through the support plate 58a. The support plate 58a can be defined by a single element (such as a stamped piece of material) or set of elements (such as a plate to which a bracket and/or one or more other elements are attached), and can take other forms, including without limitation a frame, series of supports or trusses, and the like.

In the illustrated exemplary embodiment, the support plate 58a includes an outer peripheral edge 62a that is shaped to correspond to at least part of the shape of the housing 14, although such a shape correspondence is not required to practice the present invention. The outer peripheral edge 62a of the support plate 58a can have any shape desired, and in the illustrated embodiment is substantially rectangular. Also, the outer peripheral edge 62a of the support plate 58a in the illustrated exemplary embodiment is at least partially defined by a lip or side walls oriented at an angle with respect to the rest of the support plate 58a, thereby providing one or more locations of the support plate 58a by which the support plate 58a can be connected to the housing 14. Any type of fastener or fastening feature can be employed at these locations, such as tabs or flanges 64a, 72a, apertures through which screws, bolts, nails, rivets, pins, posts, or other conventional fasteners can be passed, fingers or other

protrusions that can extend into apertures or other features in the walls of the housing 14, and the like.

For example, in some embodiments (such as that illustrated in the figures), a plurality of fasteners 64a, 72a are formed on the support plate 58a in desired locations and orientations for securing the support plate 58a to the housing 14. Any number of fasteners 64a, 72a can be located anywhere along the support plate 58a as desired, and in some embodiments are located along the outer peripheral edge 62a of the support plate 58a. In the illustrated exemplary embodiment of Figs. 1-2b, the fasteners 64a, 72a are configured as outwardly extending protrusions or tabs and are located on opposite sides of the support plate 58a. In these and other embodiments, the fasteners 64a, 72a can be configured to engage corresponding apertures 66 in the housing 14. The fasteners 64a, 72a can also be used to secure the entire first module 47a to the housing 14. The shape, size, and location of the fasteners 64a, 72a can be selected to correspond to the shape, size, and location of the apertures 66 in the housing 14.

In some embodiments, the same support plate 58a can have two or more fasteners 64a, 72a or sets of fasteners 64a, 72a (of the same or different type, and in any location or combination of locations desired) so that the support plate 58a can be fitted to two or more different fan housings 14 having different connection elements or features. Alternatively or in addition, the support plate 58a can have two or more fasteners 64a, 72a or sets of fasteners 64a, 72a (of the same or different type, and in any location or combination of locations desired) so that the support plate 58a can be mounted to the same housing 14 in two or more different orientations. As such, it is not necessary for all of the fasteners 64a, 72a of the support plate 58a to be utilized when securing the support plate 58a to the housing 14 or when mounting the first module 47a to the housing 14. In a similar manner, the housing 14 can include two or more apertures 66 or sets of apertures 66 such that two or more different support plates 58a can be coupled to the housing 14 or such that the same support plate 58a can be coupled to the housing 14 in two or more different orientations.

The support plate 58a, and the shape and configuration of the outer peripheral edge 62a, the fastener 64a, 72a, and the apertures 66 described above are presented by way of example only. It will be appreciated that the shape and configuration of the outer peripheral edge 62a, the fastener 64a, 72a, and the apertures 66 can vary greatly. Accordingly, in alternate embodiments, the shape and size of the outer peripheral edge 62a, and the number, type, and location of the fasteners 64a, 72a and apertures

66 can be changed. By way of example only, in other embodiments (not shown), the housing 14 can include fasteners 64a, 72a and the support plate 58a can include corresponding apertures 66 to mount the support plate 58a in the housing 14. As described above, other conventional fasteners (e.g., screws, bolts, nails, rivets, pins, posts, and the like) or other fastening features and elements can also or instead be used to secure the support plate 58a to the housing 14 and/or to secure the first module 47a in the housing 14.

In some embodiments, the first module 47a includes a motor 56a, and can also include a motor mounting bracket 60a that is integral with the support plate 58a or is attached to the support plate 58a via conventional fasteners or in any other suitable manner. The motor mounting bracket 60a can be positioned in any manner enabling the motor 56a to be secured to the support plate 58, and in some embodiments extends across the intake aperture 49a. The motor mounting bracket 60a can be configured to support the motor 56a within the housing 14 so that a drive shaft 51a of the motor 56a is oriented along an axis extending to a fan wheel 54a in the housing 14. In some embodiments, the motor 56a can be oriented so that the axis of the drive shaft 51a extends generally perpendicularly through the intake aperture 49a, although the drive shaft 51a can extend through or past the support plate 58a in other manners as desired. In the illustrated embodiment, the mounting bracket 60a is integrally formed with the support plate 58a.

The motor 56a can have a number of different sizes, shapes, and power outputs. In the illustrated embodiment for example, the motor 56a has a substantially cubic configuration.

Although the fan wheel 54a can be driven by any type of device (such as by an electric motor, a hydraulic motor, and the like), an electric motor 56a is employed in the illustrated exemplary embodiment. In those embodiments employing an electric motor 56a, the motor 56a can include an electrical connector 81a (such as a plug) electrically engageable with the electrical connector 80 of the housing 14 (described above) for supplying electrical power to the motor 56a. The plug or other electrical connector 81a of the motor 56a can be male, female, or can be any other type desired. Similarly, the electrical connector 80 of the housing 14 can be male, female, or can be any other type adapted for connection to the electrical connector 81a of the motor 56a.

In some embodiments, the electrical connectors 81a, 80 are releasably connectable. Although plug and socket connectors 81a, 80 are illustrated in the

exemplary embodiment of Figs. 1-2b, any other releasable electrical connectors can be employed to releasably electrically connect the motor 56a to the power supply of the fan 10.

The first module 47a can also include a fan wheel 54a. In the illustrated embodiment, the fan wheel 54a has a paddlewheel configuration. However, in alternate embodiments of the present invention, the fan wheel 54a can have a squirrel cage configuration, or can have any other rotating fan configuration desired. The fan wheel 54a is attached to and supported by the motor drive shaft 51a for rotational motion in the fan wheel chamber 52, and can include a plurality of individual blades or vanes 55a that create a centrifugal flow of air when the fan wheel 54a rotates.

In some embodiments and as shown in Fig. 1, the fan wheel 54a includes a central mounting hub 53a having one or more independent fingers that frictionally engage the drive shaft 51a of the motor 56a. In other embodiments, the fan wheel 54a can be secured to the drive shaft 51a of the motor 56a in any other manner, such as by one or more setscrews, clamps, or other conventional fasteners, by a splined, keyed, pinned, compression, or interference fit connection, and the like.

In the illustrated exemplary embodiment of Figs. 1-2b, the module 47a has a fan wheel 54a drivably connected to a motor 56a on opposite sides of the support plate 58a, wherein the fan wheel 54a is located between the base wall 24 and the support plate 58a. However, the positions of the fan wheel 54a and motor 56a can be reversed in other embodiments (in which case the locations of the fan scroll 44 and the outlet opening 30 can be changed to be appropriately positioned with respect to the fan wheel 54a). In still other embodiments, the fan wheel 54a and motor 56a can be located on the same side of the support plate 58a.

In some embodiments, the first module 47a is at least partially covered by the cover 63a, and can extend outwardly past a surface of a wall, ceiling, or other building structure in which the exhaust fan 10 is installed. The cover 63a can be part of the first module 47a, or can be an element separate from the first module 47a. The cover 63a can provide an aesthetically pleasing appearance of the exhaust fan 10 while allowing air flow into the exhaust fan 10. The cover 63a can be secured to the rest of the exhaust fan 10 in any manner, such as by screws, bolts, nails, rivets, pins, posts, and the like, by inter-engaging elements on the cover 63a and on the fan housing 14 and/or support plate 58a, and the like. For example, the cover 63a in the illustrated exemplary embodiment is connected to the support plate 58a by spring wires, which

engage corresponding recesses in the support plate 58a to secure the cover 63a to the housing 14 and/or the support plate 58a.

The elements of the second module 47b are substantially similar in many ways to the elements of the first module 47a described above. Accordingly, with the exception of mutually inconsistent features and elements between the first and second modules 47a, 47b, reference is hereby made to the description above regarding the first module 47a for a more complete description of the features, elements, (and alternatives to such features and elements) of the second module 47b.

With reference to Figs. 1 and 2b, in some embodiments, the second module 47b includes a support plate 58b, a motor 56b mountable on the support plate 58b, and a fan wheel 54b mountable on a drive shaft 51b of the fan motor 56b. A cover 63b can also be employed to cover at least part of the second module 47b. The cover 63b can be part of the second module 47b, or can be an element separate from the second module 47b.

The support plate 58b can take any shape and size, and in some cases is a substantially planar member. In some embodiments, the support plate 58b has an intake aperture 49b through which air moves in the housing 14. A motor mounting bracket 60b can be employed to mount the motor 56b to the support plate 58b, and in some embodiments extends across the intake aperture 49b. In the illustrated embodiment, the mounting bracket 60b is shaped to receive at least part of the motor 56b, such as by defining a recess in the mounting bracket 60b. For example, in some embodiments a central portion of the mounting bracket 60b can be curved with respect to the ends of the mounting bracket 60b, thereby enabling the motor 56b to be recessed with respect to the mounting bracket 60b.

In the illustrated embodiment, the mounting bracket 60b is coupled to the support plate 58b in a conventional manner (e.g., with conventional fasteners, by welding, by inter-engaging elements on the mounting bracket 60b and the support plate 58b, and the like). However, in alternative embodiments, the mounting bracket 60b is integrally formed with the support plate 58b.

Like the motor 56a of the first module 47a described above, the motor 56b of the second module 47b can have any shape, size, and power output. In the illustrated embodiment for example, the motor 56b has a substantially cubic configuration.

With continued reference to Fig. 2b, the fan wheel 54b in the illustrated exemplary embodiment is positioned on a side of the support plate 58b facing the base

wall 24. More particularly, in the illustrated embodiment, an edge of a venturi portion of the support plate 58b faces and extends toward the fan 54b. As used herein and in the appended claims, the term “venturi” includes any conduit or passage having a tapered section for concentrating fluid flow and increasing fluid velocity as the fluid flows through the conduit or passage. In other embodiments, a portion of the fan wheel 54b is received in a recess defined within the support plate 58b. Although any type, shape, and size of fan wheel 58b can be employed, the fan wheel 58b in the illustrated exemplary embodiment is a squirrel cage fan wheel 58b.

The fan wheel 54b described above and illustrated in Fig. 2b is adjacent to and spaced a distance from a recess of the support plate 58b. However, in other embodiments the fan wheel 54b or portions of the can wheel can be recessed within a recess defined by the support plate 58b. Also, in some embodiments the support plate 58b can be shaped to have a recess facing the motor 56b, which can therefore be recessed within the support plate 58b as desired (in which case the mounting bracket 60b can have a shape permitting this relationship between the motor 56b and the support plate 58b as necessary).

The second module 47b can have one or more components that are different in one or more manners than the first module 47a. For example, the second module 47b can have a larger or smaller motor 56b than the motor 56a of the first module 47a, can have a motor 56b with a different shape and/or different power output than the motor 56b of the first module 47a, and can have a different type of motor 47b than the motor 56a of the first module 47a. Alternatively or in addition, the second module 47b can have a larger or smaller fan wheel 54b (e.g., larger or smaller in diameter, larger or smaller in thickness, or larger or smaller in any other manner) than the fan wheel 54a of the first module 47a, and can have a fan wheel 54b with a different shape and/or type than the fan wheel 54a of the first module 47a. In some cases, such as where it is desirable to employ at least some of the same support plate mounting elements or features of the housing 14 to mount both modules 47a, 47b, the ability to recess the motor 56a, 56b and/or the fan wheel 54a, 54b in the support plate 58b can enable the use of differently sized motors 56a, 56b and/or fan wheels 54a, 54b in the same housing 14.

For example, the fan wheel 54b of the second module 47b is larger in thickness than the fan wheel 54a of the first module 47a. The thicker fan wheel 54b of the second module 47b can be accommodated in some embodiments by recessing

the fan wheel 54b into the support plate 58b as described above. In some embodiments, the support plate 58b is recessed and the fan wheel 54b is not receive in the recessed portion of the support plate 58. In these embodiments, the recessed portion of the support wheel 54b provides additional clearance for movement of the fan wheel 54b and can facilitate increased fan wheel performance. Similarly, the longer motor 56b of the second module 47b can be accommodated in some embodiments (such as the illustrated embodiment of Figs. 1-2b) by employing a deeper cover 63b. By way of example only, the cover 63b in the illustrated exemplary embodiment of Figs. 1-2b is different than the cover 63a, and has a deeper interior enabling a longer motor 56b to be received within the housing 14 and cover 63b.

Accordingly, some embodiments of the present invention provide an exhaust fan 10 having a module that can be changed as desired, such as to install a module with a more powerful motor, a larger fan, or having any other desirable feature(s).

In some embodiments of the present invention, the first module 47a is pre-assembled and is inserted into the housing 14 as a single integral element or unit prior to installation of the exhaust fan 10 in the structure. Alternatively, in some embodiments, the housing 14 can be installed in the building structure and the first module 47a can be inserted into the housing 14 after the housing 14 has been installed in the building structure.

After the first module 47a is inserted into the interior space 15 and is coupled to the housing 14, it may be necessary to replace the first module 47a (or one or more elements of the first module 47a). By way of example only, a user may desire a quieter fan wheel or a more powerful motor. Accordingly, the first module 47a can be removed from the housing 14 and can be replaced with the second module 47b. In addition, and as described in greater detail below, in some embodiments of the present invention, the first module 47a can be removed from the housing 14 and can be replaced with the second module 47b and/or elements of the second module 47b without removing the housing 14 from the building structure, without uncoupling the outlet fitting 12 from the exhaust duct system, and/or without disconnecting the electrical connector 80 from the field wiring 43.

To remove the first module 47a from the housing 14, the cover 63a and the fasteners 65a (if employed) are uncoupled from the support plate 58a and housing 14. The cover 63a can then be moved away from the housing 14, and in some

embodiments can be disconnected and set aside for later use with the second module 47b (or alternatively, can be discarded).

After the cover 63a of the exhaust fan 10 has been removed, the electrical connector 81a of the motor 56a can be disconnected from the electrical connector 80 of the housing 14. In some embodiments, this disconnection requires no tools, and is simply performed by manually unplugging or disconnecting the electrical connectors 81a, 80.

With the cover 63a removed, the support plate 58a is accessible through the opening 27 in the housing 14. In some embodiments, an installer can apply an upward and outward force to the support plate 58a to uncouple the fasteners 72a from the housing 14. In these and other embodiments, one or more fasteners 72a can be released or removed in any other manner, depending upon the type of fastener(s) 72a employed.

In some embodiments, after the fasteners 72a have been uncoupled from the housing 14, the support plate 58a and the rest of the first module 47a can be drawn from the housing 14. With continued reference to the exemplary illustrated embodiment of Figs. 1-2b, in some embodiments the support plate 58a can pivot (e.g., about one or more of the fasteners 64a or about another location) away from an installed position in order to remove the first module 47a from the housing 14, although any other support plate motion is possible in various embodiments. In the illustrated exemplary embodiment, the support plate 58a is pivoted in a downward direction represented by arrow 67 in Fig. 2a from a first position (shown in solid lines in Fig. 2a) in which the support plate 58a is substantially parallel to the base wall 24, toward a second position (shown in phantom in Fig. 2a), in which the support plate 58a oriented at an angle with respect to the support plate 58a.

In some embodiments, one or more of the fasteners 64a remain coupled to the housing 14 after the support plate 58a has been at least partially pivoted toward the second position so that the support plate 58a can hang from the housing 14 without requiring support from the installer.

The electrical connectors 81a, 80 described above and illustrated in the figures are accessible to an installer with the support plate 58a in place. However, in some embodiments, these electrical connectors 81a, 80 are shielded by the support plate 58a or are otherwise accessible only after the support plate 58a has been moved or removed. In such cases, after the support plate 58a has been moved or removed, the

installer can insert a hand into the interior space 15 of the housing 14 to uncouple the connector 81a of the motor 56a from the connector 80 of the housing 14.

To detach the support plate 58 from the housing 14 in some embodiments, the installer moves the support plate 58 in an upward direction (represented by arrow 69 in Fig. 2a) from the second position toward a third position (not shown), in which the fasteners 64a are moved from the apertures 66 in the housing 14. The installer can thereby uncouple the fasteners 64a from the housing 14 and can move the support plate 58a and the other elements of the first module 47a in a downward direction (represented by arrow 71) through the opening 27 and out of the interior space 15.

After the first module 47a has been removed from the housing 14, an installer can insert the second module 47b into the housing 14. In some embodiments of the present invention, the second module 47b is assembled prior to shipment to the installer. In other embodiments, the installer assembles the second module 47b and/or elements of the second module 47b prior to installation of the second module 47b in the housing 14 as described above. Accordingly, assembly of the second module 47b can be performed by the installer, or alternatively, by the manufacturer.

After the second module 47b has been assembled and/or after elements of the second module 47b have been assembled, the installer can insert the second module 47b into the housing 14 as a single integral element or unit. With reference to the illustrated exemplary embodiment, for example, the installer can move the second module 47b toward a first position with respect to the housing 14 (not shown), in which the support plate 58b is at an angle with respect to the base wall 24, such as at an acute or perpendicular angle with respect to the base wall 24. In this position, the installer can connect one or more of the fasteners 64b to the housing 14 so that the support plate 58b can hang freely from the housing 14. In those embodiments in which the connectors 81b, 80 are accessible for connection only before the support plate 58b is fully installed, the installer can then insert a hand into the housing 14 to connect the connector 81b of the motor 56b to the connector 80 of the housing 14. In some embodiments, this connection can be made manually without the use of tools.

After the motor 56b and any other electrically powered elements of the second module 47b (e.g., an electric lighting assembly) are electrically connected to the connector 80, the installer can pivot the second module 47b upwardly into the interior space 15 of the housing 14 and toward a second position, such as a position in which

the support plate 58b is substantially parallel to the base wall 24. In the second position, the installer couples any remaining fasteners 72a to the housing 14.

The support plate 58b can instead be inserted within the housing 14 in any other manner (e.g., using a sliding or translating motion or a combination of sliding and translating motions, and the like), and need not necessarily first connect one or more fasteners 64b prior to pivoting the support plate 58b as described above.

In those embodiments (such as the illustrated embodiment of Figs. 1 and 2a) employing electrical connectors 81b, 80 that are accessible after the support plate 58b has been installed in the housing 14, the installer can connect the electrical connectors 81b, 80 to establish power to the motor 56b of the second module 47b. In some embodiments, this connection can be made manually without the use of tools.

In the illustrated embodiment of Figs. 1-2b, fasteners 65b couple the cover 63b to the support plate 58b after the support plate 58b has been inserted into the interior space 15 and after the support plate 58b has been coupled to the housing 14.

However, in alternative embodiments of the present invention, the cover 63b can be coupled to the support plate 58b before the support plate 58b is inserted into the interior space 15 and before the support plate 58b is coupled to the housing 14.

While reference is made herein to embodiments of the present invention in which the first module 47a is initially installed in the housing 14 and is later replaced by the second module 47b, it should be understood that in alternative embodiments of the present invention, the second module 47b is initially installed in the housing 14 and is then replaced by the first module 47a.

In the illustrated exemplary embodiment of Figs. 1-2b, the first module 47a includes the support plate 58a, the motor 56a, the fan wheel 54a, and the cover 63a, while the second module 58b includes the support plate 58b, the motor 56b, the fan wheel 54b, and the cover 63b. Accordingly, in the illustrated exemplary embodiment of Figs. 1-2b, replacing the first module 47a with the second module 47b includes removing the support plate 58a, the motor 56a, the fan wheel 54a, and the cover 63a from the housing 14 and inserting the support plate 58b, the motor 56b, the fan wheel 54b, and the cover 63b into the housing 14.

However, in alternative embodiments of the present invention, either or both of the first and second modules 47a, 47b do not include the fan wheel 54a, 54b (respectively). In such cases, the first module 47a still includes the support plate 58a and the motor 56a (with or without the cover 63a), and/or the second module 47b still

includes the support plate 58b and the motor 56b (with or without the cover 63b). For example, in those cases where neither module 47a, 47b includes a fan wheel 54a, 54b, replacing the first module 47a with the second module 47b includes removing the motor 56a and the support plate 58a from the housing 14 and inserting the support plate 58b and the motor 56b into the housing 14. In these and other embodiments, the housing 14 can include a mounting bracket (not shown) for rotatably securing the fan wheel 54a within the housing 14 during removal and replacement of the support plate 58a and the motor 56a, and enabling the motor 56a, 56b to be connected to and disconnected from the fan wheel 54a in any suitable manner.

In some embodiments of the present invention, either or both of the first and second modules 47a, 47b do not include the motor 56a, 56b (respectively). In such cases, the first module 47a still includes the support plate 58a and the fan wheel 54a (with or without the cover 63a), and/or the second module 47b still includes the support plate 58b and the fan wheel 54b (with or without the cover 63b). For example, in those cases where neither module 47a, 47b includes a motor 56a, 56b, replacing the first module 47a with the second module 47b includes removing the fan wheel 54a and the support plate 58a from the housing 14 and inserting the support plate 58b and the fan wheel 54b into the housing 14. In these and other embodiments, the housing 14 can include a mounting bracket (not shown) for securing the motor 56a within the housing 14 during removal and replacement of the support plate 58a and the fan wheel 54a, and enabling the fan wheel 54a, 54b to be connected to and disconnected from the motor 56a in any suitable manner.

In addition, while reference is made herein to embodiments of the present invention in which the second module 47b is installed in the housing 14 after the housing 14 has been installed in a structure, in alternative embodiments of the present invention, the housing 14 can be removed from the structure prior to installation of the second module 47b.

Figs. 3-14b illustrate another embodiment of the present invention similar in many ways to the illustrated embodiment of Figs. 1, 2a, and 2b described above. Accordingly, with the exception of mutually inconsistent features and elements between the embodiment of Figs. 3-14b and the embodiment of Figs. 1, 2a, and 2b, reference is hereby made to the description above accompanying the embodiment of Figs. 1, 2a, and 2b for a more complete description of the features and elements (and the alternatives to the features and elements) of the embodiment of Figs. 3-14b.

Features and elements in the embodiment of Figs. 3-14b corresponding to features and elements in the embodiment of Figs. 1, 2a, and 2b are numbered in the 100 and 200 series.

The fan housing 114 in the illustrated exemplary embodiment of Figs. 3-14b includes a back wall 116, a front wall 118, and a pair of sidewalls 120 and 122. The back wall 116, front wall 118 and sidewalls 120 and 122 are joined to form a generally rectangular enclosure having an open bottom end and a top end closed by a base wall 124, as best shown in Fig. 14.

As illustrated in Figs. 14, 14a and 14b, the fan housing 114 is a two-piece construction formed from a first structural member 126 and a second structural member 128. The first structural member 126 is a flat sheet of material, such as galvanized steel, that is bent into the configuration shown in Fig. 14 to define the front wall 118 and the pair of sidewalls 120 and 122. In addition, the first structural member 126 defines an outlet opening 130 having three extending outlet flanges 132a-132c.

The first structural member 126 includes a first pair of mounting flanges 134a and 134b that each extend perpendicular to one of the sidewalls 120 and 122. As can be understood in Figs. 14 and 14a, each of the mounting flanges 134a and 134b are bent at an angle of 90° relative to the respective sidewall 120, 122 to which it is attached. Each mounting flange 134a, 134b includes an attachment hole 136 through which a support member, such as a screw, passes to support the fan housing 114 on the ceiling joist.

Referring now to Figs. 14 and 14b, the second structural member 128 is a flat sheet of material, such as galvanized steel, that is bent to define both the back wall 116 and the base wall 124. The second structural member 128 includes a second pair of mounting flanges 138a and 138b that each extend directly from the back wall 116 and each include an attachment hole 140. When the first structural member 126 and the second structural member 128 are joined to each other, the first pair of mounting flanges 134a and 134b are aligned with the second pair of mounting flanges 138a and 138b such that the material thickness is doubled in the area of the fan housing 114 that supports the fan housing on the ceiling joist. The second structural member 128 includes peripheral edge tabs 142 that are bent over and used to join the first structural member 126 to the second structural member 128 in a conventional manner.

In the embodiment of the invention illustrated, both the first structural member 126 and the second structural member 128 are stamped from sheets of galvanized steel, which produces only small amounts of scrap. In both the first and second structural members, the mounting flanges are formed from the continuous sheet of material, such that the mounting flanges do not need to be attached to the fan housing 114 after the fan housing has been assembled. In prior fan housings for similar exhaust fans, the mounting flanges are either attached to the fan housing in a separate step or each of the sidewalls 120 and 122, as well as the back wall 116, are formed from separate sheets of material to create the double thickness of material in the mounting flanges. By utilizing the two-piece construction of the present invention, significant material and labor costs can be saved during construction of the fan housing 114.

As can be understood in Fig. 14, the fan housing 114 is formed from two individual pieces of material that are each bent to desired configuration and joined to each other. Most importantly, the two-piece configuration for the fan housing 114 provides for a double material thickness in the area of the fan housing that supports the weight of both the fan housing 114 and the internal operating components.

Referring now to Fig. 4, the fan housing 114 generally defines an open interior that includes a curved sheet of metallic material that defines a centrifugal fan scroll 144. As can be seen in Fig. 14, top edge surface 146 of the fan scroll 144 contacts the inner surface of the base wall 124. Fan scroll 144 is secured to the sidewall 122, back wall 116 and the front wall 118. The fan scroll 144 includes a bottom edge surface 148 that includes a reduced height pre-load notch 150, the significance of which will be discussed in greater detail below. The fan scroll 144 defines a fan wheel chamber 152 that is sized to receive a fan wheel 154, as best illustrated in Fig. 4. The fan wheel 154 includes a plurality of individual vanes that create a centrifugal flow of air when the fan wheel 154 rotates. The fan wheel 154 is mounted to a driving motor 156 that is operable to rotate the fan wheel to create a flow of air out of the outlet opening 130 and through the outlet fitting 112. The motor 156 is supported within the fan wheel chamber 152 by a motor support plate 158 and an attached motor mounting bracket 160.

Referring now to Figs. 4 and 5, the motor support plate 158 includes a first peripheral edge flange 162 having a pair of tabs 164 that extend completely through corresponding slots 166 formed in the sidewall 122 of the fan housing 114. The

interaction between the pair of tabs 164 formed on the motor support plate 158 and the slots 166 formed in the sidewall 122 aid in holding the motor support plate 158 within the fan housing 114 against the force of gravity.

Once the pair of tabs 164 have been inserted into the slots 166 in the sidewall 122, the opposite edge of the motor support plate 158 can be pushed upward, as illustrated by arrow 168, until an angled tab 170 formed on a second peripheral edge flange 172 engages a slot 174 formed in the sidewall 120. When the angled tab 170 is received within the slot 174, the motor support plate 158 is securely held within the open interior of the fan housing 114 between the rectangular sidewalls 120 and 122.

When the motor support plate 158 is installed within the fan housing 114, as best illustrated in Fig. 5, a detent 176 stamped into the motor support plate 158 contacts the bottom edge surface 148 of the fan scroll 144. The detent 176 spaces the remaining portions of the motor support plate 158 slightly above the bottom edge surface 148 of the fan scroll 144. The pre-load notch 150 formed on the fan scroll 144 creates a larger physical separation between the motor support plate 158 and the fan scroll 144 in that area, which allows the motor support plate 158 to move slightly upward, as illustrated by arrow 168, such that the angled tab 170 can be removed from slot 174 to permit the motor support plate 158 to be removed from within fan housing 114. Without the decreased height of the fan scroll 144 along the area identified by the pre-load notch 150, removal of the motor support plate 158 would be much more difficult due to the nearly identical dimensions of the fan housing 114 and the motor support plate 158.

Referring back to Fig. 4, the exhaust fan 110 includes a receptacle panel 178 that supports at least one electrical receptacle 180 within the fan housing 114. In the embodiment of the invention illustrated, the single electrical receptacle 180 receives the plug 181 of the motor 156. An additional electrical receptacle 180 could also be supported by the receptacle panel 178 to provide power for an optional lighting assembly (not shown). Electrical receptacle 180 includes a pair of wires 182 that are connected to the supply of electricity for the home in which the exhaust fan 110 is installed to provide power for the fan. In accordance with the present invention, the receptacle panel 178 is removably mounted within the fan housing 114 and can be removed and installed without the aid of any tools. The wires 182 are field-connected to power source wires that pass through a wire plate 184 connected to both the base wall 124 and the sidewall 120. The wire plate 184 includes a horizontal access hole

186 and a vertical access hole 188 to permit the power source wires to pass through either the base wall 124 or the sidewall 120. The vertical access hole 188 is shown in the preferred embodiment of the invention as including a knockout that can be removed if vertical wiring access is required. The wire plate 184 can be removed from the fan housing 114 to provide unlimited wiring access from the outside of the fan housing 114. The wire plate 184 can be reverse-mounted to the fan housing 114 to permit the power source wires to pass through either the base wall 124 or the sidewall 120 without removing the knockout.

Referring now to Fig. 11, the receptacle panel 178 generally includes a horizontal base plate 190 and a first locking tab 192 that extends vertically from the base plate 190. Locking tab 192 extends through a mounting slot 194 formed in the front wall 118 to aid in holding the receptacle panel 178 in contact with the front wall 118. Additionally, a pair of ears 196 extend vertically from the base plate 190 and pass through corresponding slots in the front wall 118 to aid in holding the receptacle panel 178 in place.

After the locking tab 192 and ears 196 are positioned in the corresponding slots in the front wall 118, a locking flange 198 extending vertically from the base plate 190 is pressed behind a retaining clip 200 formed as part of the sidewall 120. The retaining clip 200 includes a curved portion 202 that is received within an open notch 204 formed in the locking flange 198 such that the retaining clip 200 retains the receptacle panel 178 in the position shown.

When the receptacle panel 178 is pressed into its installed position as shown in Fig. 10, a spacer tab 206 protruding from the base plate 190 contacts the bottom edge surface 148 of the fan scroll 144 to create an opening 208 between the base plate 190 and the fan scroll 144. The opening 208 provides adequate spacing between the base plate 190 and the fan scroll 144 to allow a wire 182 of the receptacle 180 to pass between the top edge 148 of the fan scroll 144 and the base plate 190. The spacing between the base plate 190 and the fan scroll 144 prevents inadvertent severing of the wire 182 during installation of the receptacle panel 178.

Referring now to Figs. 9 and 11, the receptacle panel 178 further includes a horizontal removal tab 210 that can be grasped by the user to pull the receptacle panel 178 from its installed position. Specifically, the removal tab 210 is positioned between the fan scroll 144 and the sidewall 120 and can be grasped by the user to pull the receptacle panel 178 out of the fan housing 114, as illustrated by arrow 212,

against the frictional interaction formed between the retaining clip 200 and the locking flange 198.

The removable receptacle panel 178 of the present invention allows a builder or electrician installing the exhaust fan 110 to connect the wires 182 to the supply of electricity for the house outside of the fan housing 114. Once the wires 182 have been connected to the supply of electricity for the home, the wires 182 can be pulled through the fan housing 114 and the receptacle panel 178 installed within the fan housing 114 as previously described.

Referring now to Figs. 3 and 7, the back wall 116 of the fan housing 114 includes two series of vertically spaced view holes 214. The view holes 214 allow the installer of the exhaust fan 110 to look through the back wall 116 and the open interior defined by the fan housing 114 and view the position of the ceiling joist 216 relative to the fan housing 114. The view holes 214 are spaced from each other by set distances to accommodate common thickness' of drywall. For example, the uppermost hole 214a shown in Fig. 7 can be aligned with the bottom of the joist 216 when drywall having a thickness of 1 1/4 inches is utilized. The middle hole 214b corresponds to one inch thick drywall, while the bottom hole 214c is spaced for use with 5/8 inch thick drywall. In the preferred embodiment of the invention, an indicia corresponding to the drywall thickness for the individual view hole 214 is stamped into the back wall 116 immediately next to the view hole 214.

In the past, the installer of an exhaust fan had to measure the distance from the bottom edge of the fan housing 114 to the bottom of the joist in order to determine the proper placement of the fan housing. By utilizing the two spaced series of view holes 214, the installer or electrician can not only correctly space the bottom edge of the fan housing from the bottom of the ceiling joist, but also ensure that the fan housing 114 is level by properly aligning the two series of view holes 214.

Referring now to Figs. 3 and 8, the back wall 116 further includes a pair of bend down tabs 218 that can be moved from the generally vertical, storage position shown in Fig. 3 to a horizontal, operating position shown in Fig. 8. When the bend down tabs 218 are in the horizontal, operating position, the tabs 218 can be pressed against the bottom edge of the ceiling joist 216 to provide the required spacing for 1/2 inch thick drywall 219, which is the most common drywall used in newly constructed homes. Thus, if the installer or builder knows that 1/2 inch thick drywall is going to be used in the bathroom in which the exhaust fan 110 is installed, the installer can

press the bend down tabs 218 into their horizontal position, as indicated by arrow 220, and place the bend down tabs 218 in contact with the bottom edge surface of the ceiling joist 216, thus quickly and accurately positioning the fan housing 114 on the ceiling joists 216. In addition to being contained on the back wall 216, a pair of similar bend down tabs 218 can also be formed in the front wall 118 of the fan housing 114, as illustrated in Fig. 3. In this manner, the two pair of bend down tabs 218 can be used to level and support the fan housing 114 between adjacent ceiling joists 216.

Referring now to Fig. 12, the outlet fitting 112 includes a plastic damper flap 222 that pivots about a pivot pin 224 to open or block access to the outlet opening 130 formed in the fan housing 114. When the motor 156 and fan wheel 154 are rotating, airflow from the exhaust fan 110 forces the damper flap 222 to rotate outward in a clockwise direction to permit airflow to be vented to the outside of the home. However, when the motor 156 and fan wheel 154 are inactive, a back draft causes the damper flap 222 to rotate in the counter-clockwise direction to prevent the back draft from entering into the bathroom or enclosed area in which the exhaust fan 110 is mounted.

In the preferred embodiment of the invention illustrated, a pair of stop pins 226 extend from the back face surface 227 of the damper flap 222 and contact a stop surface 228 formed in the outlet fitting 112. The stop pins 226 provide small points of contact with the stop surface 228 to reduce the amount of noise generated when the damper flap 222 is pressed against the stop surface 228 by a back draft. In previous embodiments of similar exhaust fans, entire damper flap 222 contacts the stop surface 228 and generates a perceptible amount of flapping noise.

Referring now to Fig. 13, the fan wheel 154 includes a central mounting hub 230 having independent fingers 231 that receives a drive shaft 232 of the driving motor 156. The mounting hub 230 includes a central bore 234 having an internal diameter approximately equal to the outer diameter of the drive shaft 232. A retaining band 233 surrounds the base of the independent fingers 231 to limit the outward flexing of the fingers 231. Thus, the mounting hub 230 is sized to receive the drive shaft 232 and retains the drive shaft 232 in the central bore 234 through a tight friction fit.

In accordance with the present invention, an insertion portion 236 is formed in the outer end of the mounting hub 230 to aid in insertion of the drive shaft 232 into

the mounting hub 230. The insertion portion 236 is counterbored in the fingers 231 and has an inner diameter that is slightly greater than the inner diameter of the remaining portion of the central bore and thus slightly larger than the outer diameter of the drive shaft 232. In this manner, the drive shaft 232 can be easily inserted into the insertion portion 236 without any force being applied between the drive shaft 232 and the fan wheel 154. This feature is particularly important during assembly of the exhaust fan 110 since the fan wheel 154 is initially applied to the drive shaft 232 by a human assembly person during fabrication of the exhaust fan 110. After the human assembly person has placed the fan wheel 154 on the drive shaft 232, an automated machine presses the fan wheel 154 completely downward onto the drive shaft 232 to finally install the fan wheel 154 on the drive shaft 232. Without the insertion portion 236, the human assembly person would have a significantly more difficult time initially placing the fan wheel 154 on the drive shaft 232.

The embodiments described above and illustrated in the figures are presented by way of example only and are not intended as a limitation upon the concepts and principles of the present invention. As such, it will be appreciated by one having ordinary skill in the art that various changes in the elements and their configuration and arrangement are possible without departing from the spirit and scope of the present invention. Also, it should be noted that terms such as “front”, “back”, “top”, “bottom”, “side”, “upward”, “downward” and other terms of orientation used herein and in the appended claims are used for purposes of description only and neither indicate nor imply any limitation regarding the orientation of the present invention. Also, terms such as “first” and “second” are used herein and in the appended claims for purposes of description and are not intended to indicate or imply relative importance or significance.